Feeding The World-

Origins of Ag-

- Thought to have 1st occurred in Near East 12,000 years ago
- Most crops came from Roman cultivation & were derived from wild species

- Famine: widespread starvation caused by a shortage of food
  - Lack of rain
  - Loss of soil
  - War

- Malnutrition: condition that occurs when people do not consume enough calories & do not eat a variety of foods to fulfill the body's needs

World Food Production, 2004

Wheat	620			
Corn	720	Fish	135	Metric tons [in Millions]
Rice	605	Beef	65	
Pots.	330	Pork	100	
Soy.	205	Poultry	80	
Beans	30			

- Ecology of Food:
  Most difficult thing about growth of human populations? Feeding everyone while maintaining normal ecosystems

  - Efficiency: measure of the quantity of food produced on a given area of land with limited inputs of E & resources

  - Yield: amount of food that can be produced in a given area

- World Food Problems: Current Pop. 7+ Bil.
  - World's farmers produce enough grain to feed up to 10 billion people on an adequate vegetarian diet
  - Poverty: malnutrition is due almost entirely to poverty [live on less than $1/day]
    - Mostly in Africa, Asia, & S. America (Mts)

- Green Revolution
  - Between 1950 & 1970 Mexico ↑ed its production of wheat 8x & India doubled its rice production without increasing farmland
  - Results of new varieties

"Want to make a dent in world hunger?"
Build Better Roads —Kenneth Quinn [World Food Prize]

Norman Borlaug - "Father of Green Revolution"

1950s
- Developed semi-dwarf, high-yielding, disease resistant wheat varieties in Mexico
- Led intro. of high yield varieties & modern agriculture practices to Mexico, Pakistan, & India
- credited with saving over 1 billion people worldwide from starvation

1980s
- Later helped apply these methods to food production in Asia & Africa

Dream was to "transfer rice immunity to cereals such as wheat, maize, sorghum, & barley, & transfer bread-wheat proteins (gliadin & glutenin) to other cereals, especially rice & maize"

- Believed GMOs was the only way to increase food production as the world was running out of unused arable land
- GMOs were not inherently dangerous "because we've been genetically modifying plants & animals for a long time. Long before we called it science, people were selecting the best breeds."

GMOs

Genetically Modified organism: organism whose genetic material has been altered using engineering techniques

Involves: mutation, insertion, or deletion of genes
- Inserted genes usually come from another organism

Oldest form of genetic modification is Selective breeding [selecting desirable traits & breeding to obtain results]

1st accomplished by Herbert Boyer & Stanley Cohen in 1973

- When genetic material from another species is added it is called a transgenic organism

- Uses
  - Biological & Medical RSx
  - Pharmaceutical Drugs
  - Experimental medicines [Gene therapy]
  - Agriculture [golden rice, resistance to herbicides]

- Bacteria were the 1st to be modified
  - Insulin to treat diabetes
  - Clotting factors to treat hemophilia
  - HGH to treat dwarfism
  - Enzymes in processed foods

- Plants [new colors & different crops]
  - resistance to pests, herbicides
  - ↑ed nutritional value
  - production of pharmaceuticals [pharming]
  - Development outside normal range

1st commercial GMO crop - 1996

Most important & most recognized = BT corn
[BT toxin insecticide, not harmful to mammals]

- Mammals [slow, tedious, expensive]

  Why?
  - RSx human diseases
  - Industrial or consumer products [fibers]
  - Pharmaceuticals / tissue implantation
  - Hypoallergenic pets
  - Enhance prod. (↑) or food quality traits [feed eff.]
  - Improve animal health [dis. resist.]

+ Livestock
  ↳ animals domesticated, raised to be on a farm or ranch or to be sold for profit
    Ex. Chicken, Sheep, cattle, Pigs, Goats, Horses, Mules, & Donkeys

• Uses?

Meat	Leather	Fertilizer
Wool	Draft [cart or plow]	Medicines
Eggs		Gelatin

Ruminants: used to convert plant material [stems & shrubs] into food humans can digest ~ milk & meat [beef, lamb, & goat]
  • Microorganisms / bacteria in rumen allow them to digest & breakdown plant components into VFA's that can then be converted to proteins, lipids, CHOs, & vitamins

Poultry: Since 1961 pop. of chickens worldwide has increased greater than any other livestock animal
  – Ga ranks 1st for broilers [1st than most countries]

Animals & Agriculture-

- Energy needed to grow plants is less than energy needed to raise animals as food.
  - However animal proteins are classified as ↑quality because they provide all 10 EAA for humans, while plants are classified as ↓ quality proteins because they don't provide all 10 EAA

- domesticated: bred & managed for human use
  - Today 50 species are domesticated
    - Chicken
    - Cattle
    - Fish
    - Sheep
    - Honeybees
    - shellfish
    - Water Buffalo
    - Goats
    - Silkworms
    - Pigs

- Food from water
  - Major source of food for humans
  - Leads to <u>overharvesting</u> [catching or removing from a population more than the population can replace]
    - Fix? No-fish zones to replenish pops.

Today, 23% of Seafood → Aquaculture - "ing aquatic organisms for human use
Ex. Oyster Farms, Salmon Ranches [vs: catfish, oysters, salmon (crayfish, Rainbow Trout]

Began in China 4000 yrs ago

- Sheep, Pigs, & Rats
  - Human-alpha-1-antitrypsin in sheep milk
  - Transgenic pigs to make xenotransplantation more productive & less rejection
  - Green- fluorescent cats to treat HIV/AIDS or FIV
  - Anticoagulant from goat milk to ↓ probability of clotting during childbirth

Harvest of Fear -

- Earth Liberation Front declared war against biotechnology
- called GMOs "Frankenfood"
- Creating medicines & more nutritions
- 85% of food we eat comes from large farms
- Cotton #1 user of pesticides
  ↳ BT cotton & corn [resistance to insect]
- 1/3 of all corn
  Majority of all cotton & soybeans > BT
- GMOs were treated like normal grains & put through normal processing
- European countries said GMO food must be labeled
- Majority of Americans trust FDA & USDA

- Been RSx effects since 1970 & no known effects have shown up

- Starlink only approved for use ō animals as it was known to produce allergens

- We've been G.E foods for 1000 of years = selective & cross breeding

- Transgenics - genes from 1 organism to another

Soils

- Soil- surface layer of land; layer of natural materials on the earth's surface containing both organic & inorganic materials & is capable of supporting life
  - Four components:
    - Inorganic Material 45-48% → >1/2 Solid Material
    - Organic Material 2-5%
    - Water 25% → >1/2 pore space
    - Air 25%

(% vary from soil type to soil type)

- Inorganic Material: weathered mineral & rock particles
- Organic Material: dead plant & animal materials in various stages of decay

- Soil formation: formed slowly; results from natural forces acting on mineral & rock portions of the earths surface

- Parent Materials: materials underlying the soil & from which the soil was formed; 5 categories
  - Minerals & Rocks:
    - M: Solid, inorganic, chemically uniform substances that occur naturally
    - R: Aggregates of minerals; Igneous are formed by the cooling of molten materials; Sedimentary are formed by solidification of sediment (3/4 of earths

surface); Metamorphic are formed from igneous & sedimentary rocks that have been reformed by great heat or pressure

- Glacial Deposits: As glaciers moved they scooped up massive amounts of surface materials & left behind deposits of rocks & parent materials
- Loess Deposits: Wind blow silt
- Alluvial & Marine Deposits: waterborne sediments Alluvial from fresh water moving & Marine were formed on ancient ocean floors; often form deltas or floodplains
- Organic Deposits: partially decayed material of dead plant material that begins to buildup in swampy & marshy areas; becomes muck or peat soil which can support plant life

- Weathering: When minerals & rocks are exposed to the weather, when they begin to break into smaller pieces

(temp. Δs) Ex: top of rock gets really hot while bottom is still really cold ~ causes cracks which breaks rock

(water action) - Some minerals dissolve in water & can dissolve from rock when exposed to water (Caves)

(Plant roots) - Growing plants speed up weathering

(Ice expansion) - when water freezes around rock it expands & breaks it up

(Mechanical grinding) - Sand against rock, glaciers moving towards each other, water moving soil & gravel together

Soil Characteristics

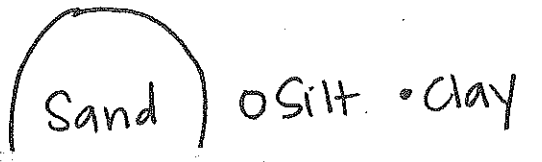
Soil Texture - Refers to the proportion and size of soil particles

Can be determined by:
1. Make a stiff mud ball
2. Rub the mud ball between the thumb and forefinger
3. Note the degree of coarseness and grittiness caused by sand particles
4. Squeeze mud between your fingers and then pull thumb and forefinger apart
5. Note the degree of stickiness caused by clay particles
6. Make soil slightly more moist and note the clay leaves a "slick" surface on thumb and fingers

Types of Soil -

- Coarse-textured (Sandy) Soil: loose and single grained; individual grains can be seen and felt; squeeze when dry and will fall apart when pressure is released; squeeze when wet and will form a cast
- Medium-textured (Loamy) Soil: even mixture of clay, sand, and silt; gritty feel; squeeze when moist and will form a cast that won't fall apart easily
- Fine-textured (clay) Soil: usually forms hard lumps or clods when dry; very sticky when wet; will hold thumb and forefinger together with stickiness

Soil Particle Size

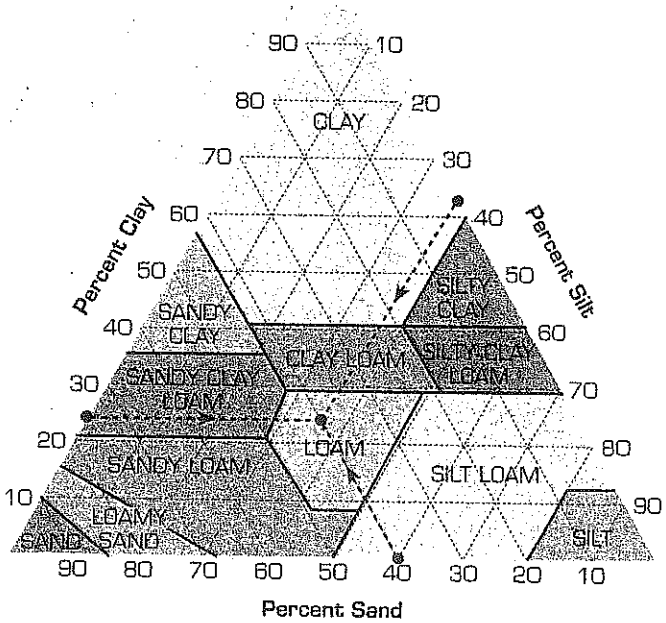


30% Sand
60% Silt
10% clay

Silt Loam

40% clay
30% Silt
30% Sand

Determining Soil Texture



Example: Identify a soil that is 40% sand, 22% clay, and 38% silt.
1. Find 40 on the side for sand.
2. Draw a line in the direction of the arrow.
3. Do the same for clay (22%) and silt (38%).
4. The spot where the three come together is the soil texture. In this case, the soil is a loam.

A textural name may include a prefix naming the dominant sand size, as in "coarse sandy loam."

Soil Characteristics

Soil Properties -

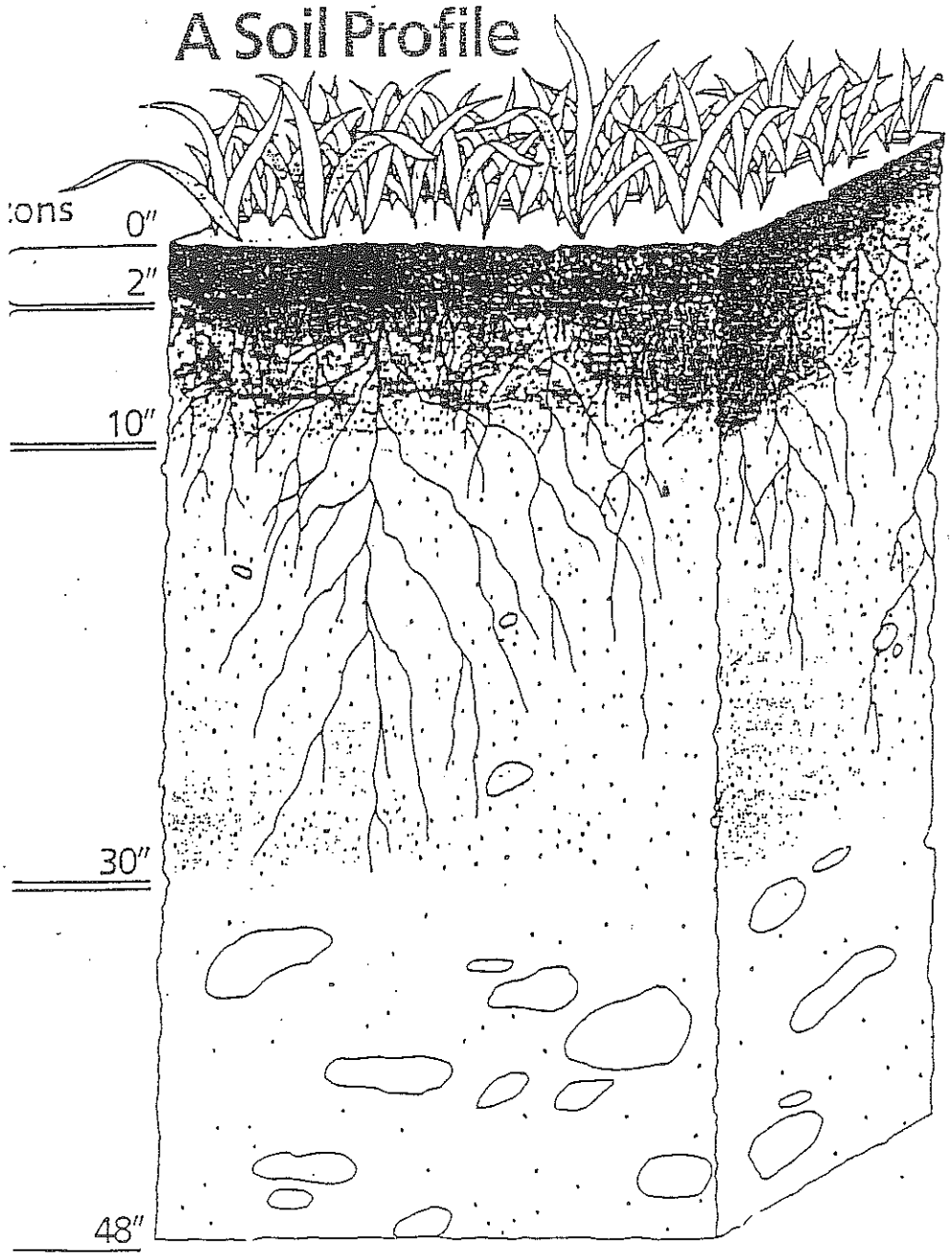
- Slope - determines productive potential of soil; defined as the angle of the soil surface from the horizon.
- Texture - proportions of sand, silt, and clay in soil; coarse soil has more sand and drains more rapidly (can lead to drought); fine soil has more clay and drains slowly, making it wetter.
- Soil Drainage - excessive wetness reduces soil productive potential by damaging root systems
- Flood hazard - frequent floods = less productive potential
- Erosion - degree the soil has already been damaged; appearance of large gullies or loss of topsoil indicates erosion
- Horizon Thickness - thin layers limit potential of soil

Soil Formation - Factors affecting soil formation

- Climate & Location: affects rate of weathering; as temperature increases the rate of chemical reaction, the growth of bacteria, fungi, organisms, and plants increase; too much rainfall leaches nutrients from the soil
- Living Organisms: cause decay of organic material; without soil microbes, organic material would not decay; earthworms aid in decomposition & soil mixing

- Parent Material: influences fertility & texture; composes the C horizon (layer) of a soil profile
- Topography: affects distribution of soil particle & water; on a steep slope, loose material is moved downward by run-off water, gravity, & animals; satvrated soil reduces the action of soil forming activities
- Time: formed by chemical & physical weathering over time
- weamering: causes soil to develop, matvre, & age; caused by temperature changes such as heating, cooling, freezing, & thawing.

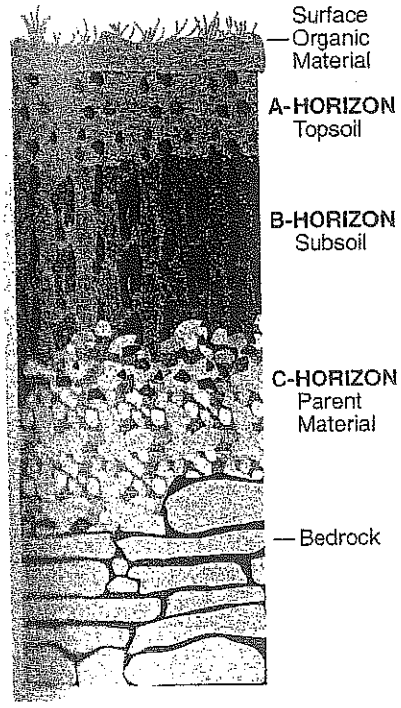
- O Horizon:
  - Located on the surface
  - Composed of organic matter and a small amount of mineral material
  - Colors: Black, Dark Brown
  - Structure: Loose, crumbly



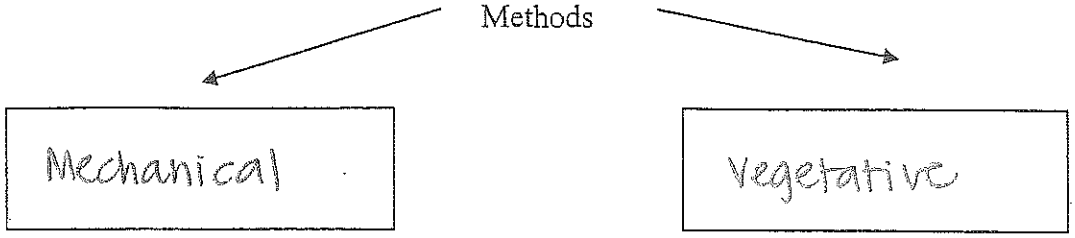
Soil Characteristics

Soil Profile - most soils have 3 distinct layers or soil horizons

- C Horizon: Composed mostly of parent material
  - Consists of weathered rock & minerals
  - Important for storing & releasing water
  - Colors: variable
  - Structure: Loose to Dense
  - Soft enough to dig into or crumble
  - Very few plant roots
- B Horizon: Referred to as subsoil
  - Contains little parent material
  - Color: Brown, Red, yellow, or Gray
  - Structure: Larger chunks, crumbly
  - Has many plant roots
- A Horizon: Known as topsoil
  - Highest content of organic matter
  - Color: Gray, Brown, Black
  - Color is from humus content (humus is decomposed plant material)
  - Most productive portion of the soil
  - Structure: Generally loose, crumbly
  - Composed of mineral and organic matter
  - Contains most plant nutrients



Two types of Erosion Control Methods



Examples

1. Diversion Ditch
2. Water ways
3. Water chute
4. Sediment Basin
5. Bank Protection
6. Terracing

Examples

1. Lawn
2. Sodding
3. Mulching
4. Ground covers

Erosion - process that breaks things down into smaller things; process by which the surface of the earth gets worn down

Agents of erosion - water, wind, waves, and ice

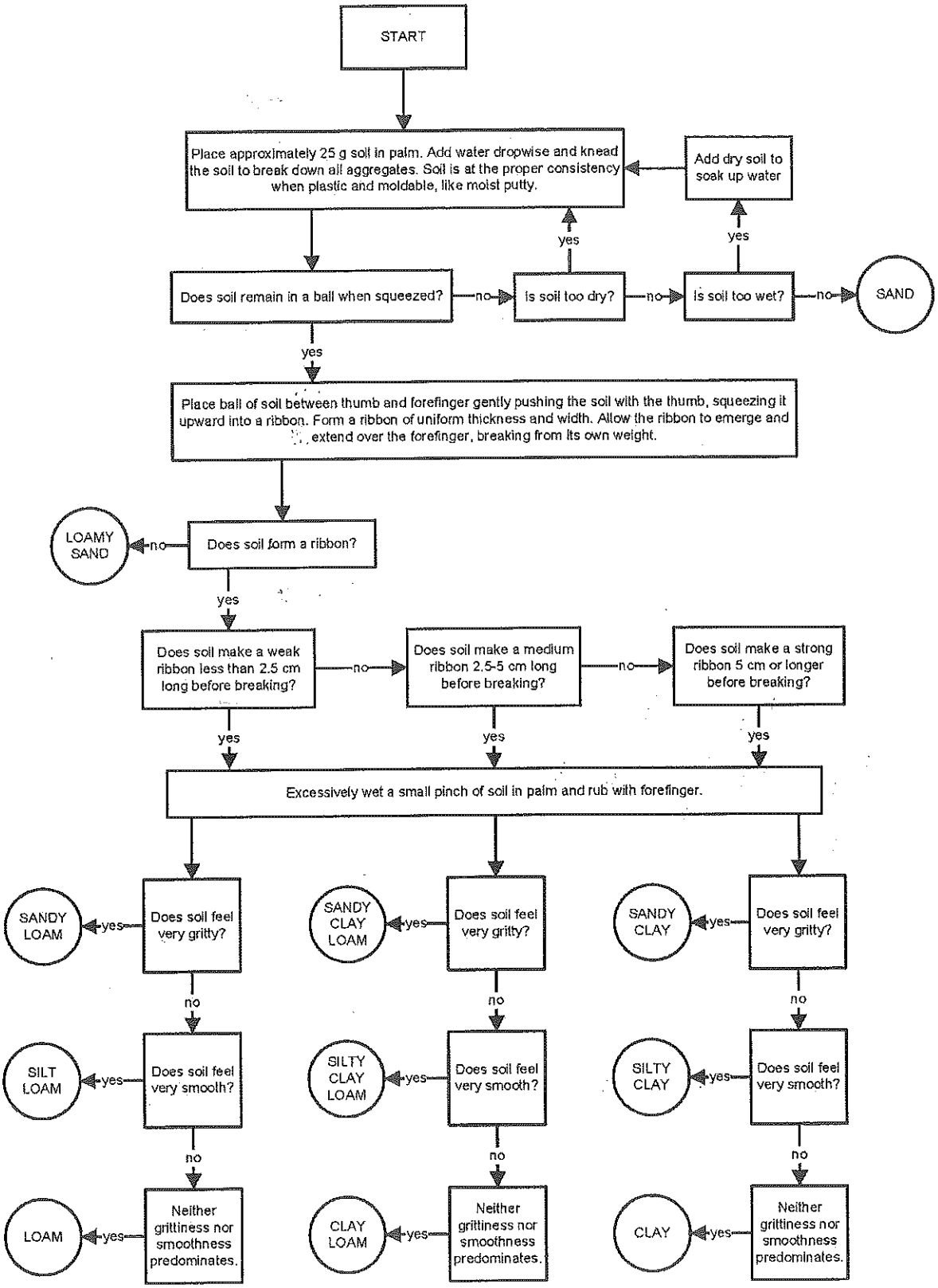
- Water Erosion - water in all forms is erosional; raindrops, streams, run-off water in fields and yards; most common agent of erosion
- Wind Erosion - occurs mostly in deserted places; can form sand dunes
- Wave Erosion - creates coastal erosion; energy of waves and chemical content of water erode rock on shoreline; erosion of sand is very common
- Ice Erosion - caused by glaciers hitting things and getting frozen and pieces falling off and scrapping the ocean floor

Types of erosion - mechanical and chemical

Erosion Control Methods - Mechanical & Vegetative

- Mechanical
  - Diversion Ditch
  - Water Ways
  - Water Chute
  - Sediment Basin
  - Bank Protection
  - Terracing
- Vegetative
  - Lawn
  - Sodding
  - Mulching
  - Ground Covers

USDA Soil Analysis Chart – Texture by Feel Analysis of Soil



Natural Resources
Soil Texture Lab

Name: _____
Date: _____

Use the following procedure for conducting a ribbon test to determine soil texture for the four soil samples given.

1. Obtain a large enough sample of soil to form a one-inch ball (about the size of a small egg). The sample should contain no gravel or bits of debris. If needed, run the sample through a sieve to remove such material.
2. Moisten the sample to a medium moisture level; the soil should be like workable putty. Work the soil between the fingers until it is uniformly moist and dry lumps are wetted. Note any grittiness that indicates sand or stickiness that indicates clay.
3. Mold the sample into a small ball and try to lightly squeeze it. If the ball breaks at the slightest pressure, the soil is a sand or coarse sandy loam. If the ball stays together but changes shape easily, it is a sandy loam, loam or silt loam. Finer-texture soils resist molding.
4. Squeeze out a ribbon between the thumb and forefinger, noting how long a ribbon can be formed before it breaks. Use this guide to narrow down the choice of textures: *no ribbon*: loamy sand, *ribbon shorter than one inch*: loam, silt, silt loam, sandy loam, *ribbon one to two inches*: sandy clay loam, silty clay loam, clay loam, *ribbon two inches or longer*: sandy clay, silty clay, clay
5. Take a small amount of the soil sample in between two finger and wet it excessively noting how the soil feels. Sand feels gritty, silt feels smooth and clay feels sticky. Use all of these observations to determine the textural class for the soil sample.

Soil Sample 1: Sandy Loam or Clay

Soil Sample 2: Clay

Soil Sample 3: Loam

Soil Sample 4: Sandy Loam or Clay

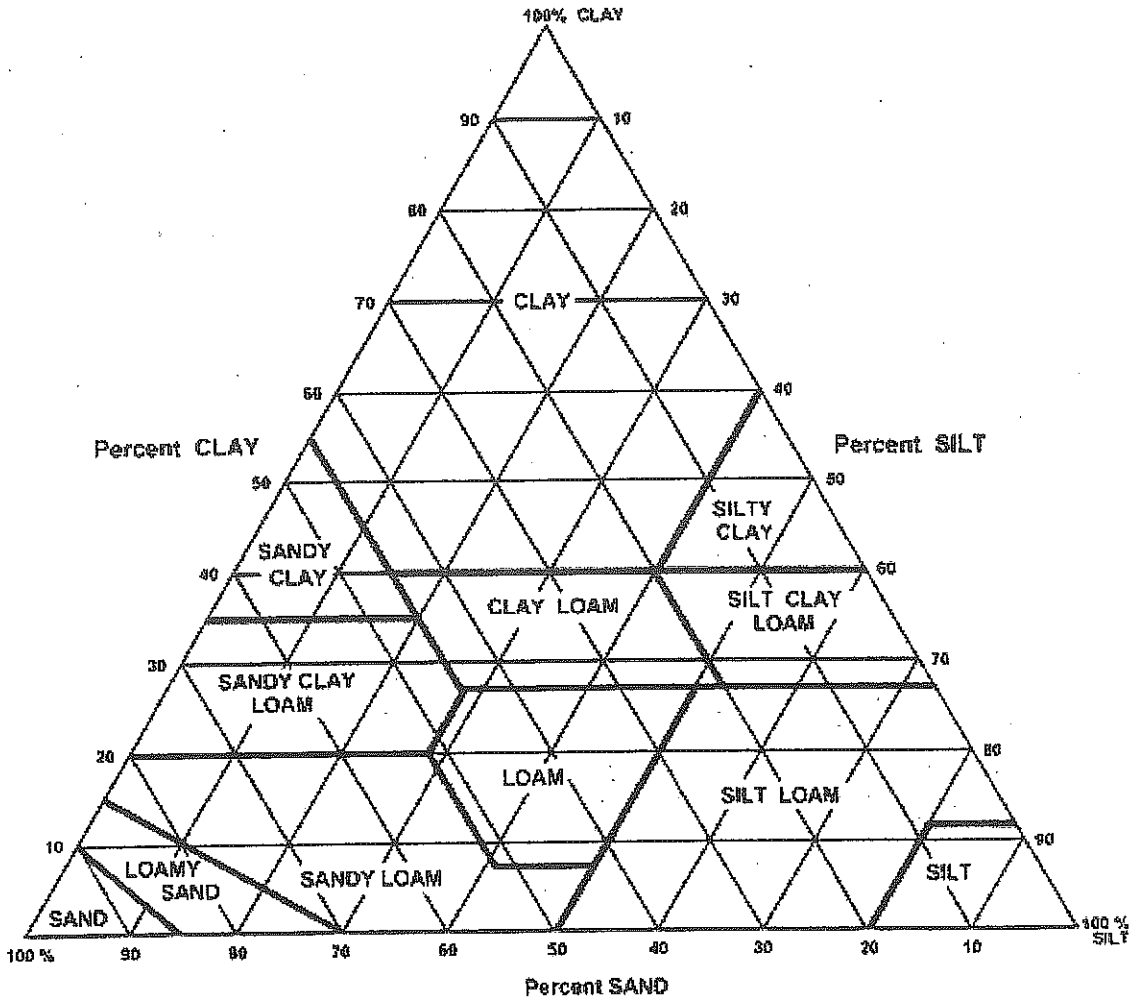
Use the soil textual triangle to determine the textural class of soils with the following percentages of sand, silt and clay.

1. 40% sand, 40% silt, 20% clay: Loam
2. 60% sand, 30% silt, 10% clay: Sandy Loam
3. 10%sand, 40% silt, 50% clay: Clay or Silty Clay

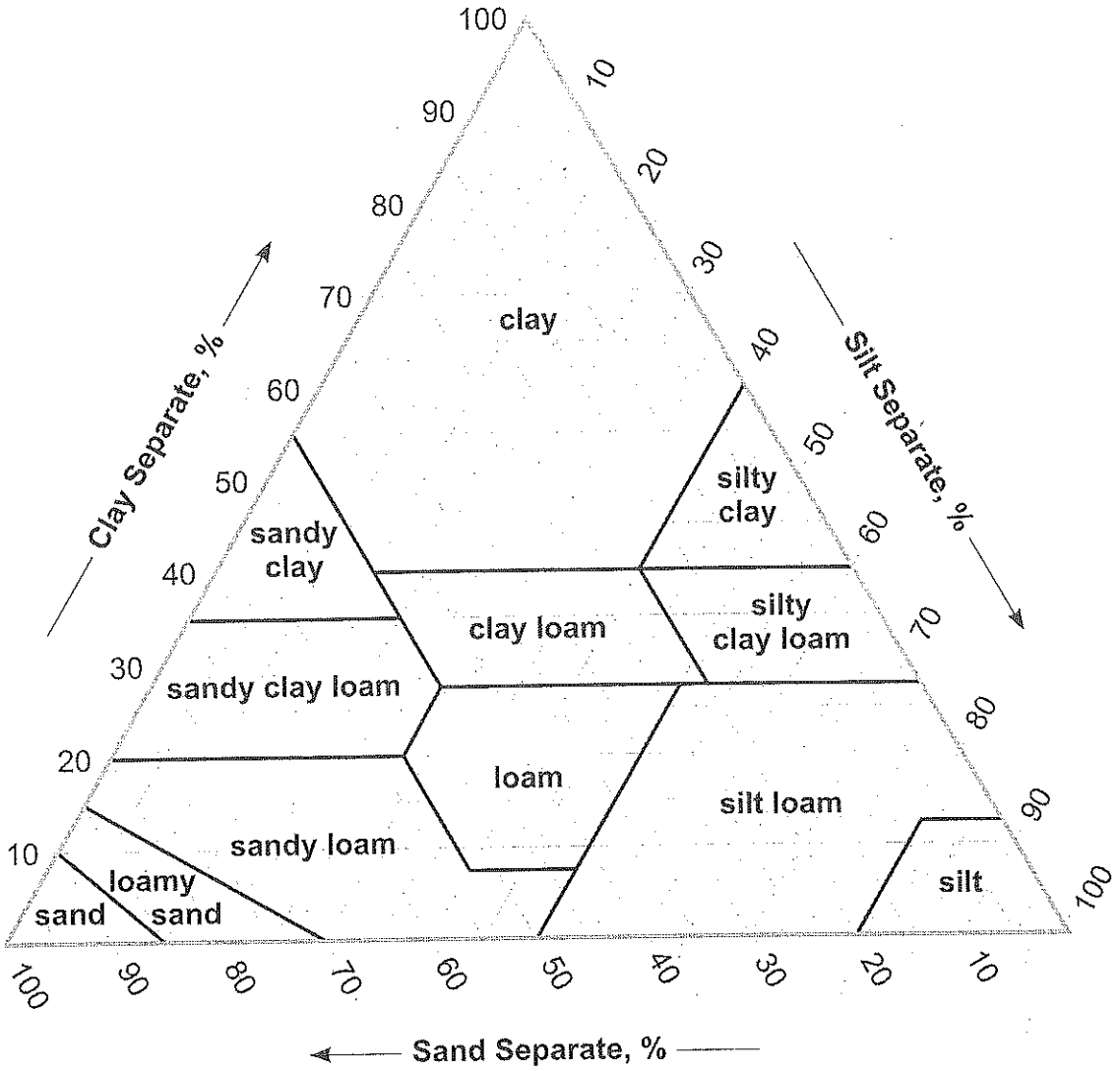
Give the percentages of sand, silt and clay that must be present for a soil to be classified into each of the following textural classes.

1. Loamy sand: 70-95% Sand, 10-15% clay, 0-25% Silt
2. Clay loam: 20-45% Sand, 25-40% Clay, 60-73% Silt
3. Silt: 88-100% Silt, 0-12% clay, 0-20% Sand

Textural Triangle



Soil Textural Triangle



Practice

40% C
30% Si
30% Sa
Clay Loam [clay]

40% C
50% Sa
10% Si
Sandy clay

90% Sa
5% Si
5% C
Sand

20% C
60% Sa
20% Si
Sandy Loam [Sandy Clay Loam]

38% Si
42% C
20% S
Clay

65% Si
35% Sa
0% C
Silt Loam

35% Sa
60% Si
5% C
Silt Loam

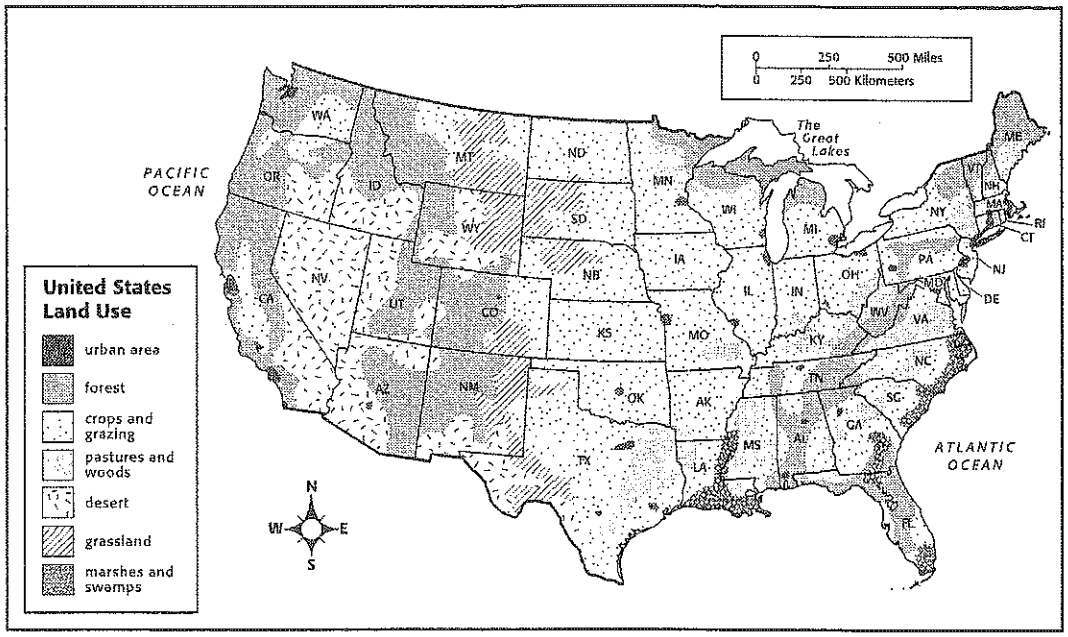
70% C
28% Sa
2% Si
Clay

Name _____ Class _____ Date _____

Skills Worksheet

LAND USE

Map Skills



Humans use land to grow food and for living space, among other uses. They change land, too. For example, through irrigation, land that was once unsuitable for growing crops can be farmed. Marshes and swamps may be drained. This map shows land use in the United States.

Use the map above to answer the questions below.

1. **Using a Key** According to this map, what types of land are used the least?

Marshes & Swamps

2. **Using a Key** What are the most common uses of land in the United States?

Crops & Grazing, Pastures & Woods

3. **Inferring Relationships** What land-use designations are most likely the result of human manipulation?

Urban areas, crops, & grazing

4. **Analyzing Data** What land-use designations do you think the crops and grazing lands might have had before they were farmed?

Grassland or Pastures & Woods

5. **Making Conclusions** How might other types of land-use have affected the development of urban areas?

Forests provide lumber for construction, while land suitable for crops & grazing made agriculture near urban dwellers possible.

Name _____ Class _____ Date _____

Skills Worksheet

Concept Review

MATCHING

In the space provided, write the letter of the term or phrase that best matches the description.

G 1. damaged rangeland
E 2. protected land
F 3. purified water
A 4. bridges
D 5. low population density
B 6. development
C 7. clear-cutting
H 8. rangeland and urban land

a. infrastructure
b. urbanization
c. deforestation
d. rural
e. wilderness
f. ecosystem services
g. overgrazing
h. human uses of land

MULTIPLE CHOICE

In the space provided, write the letter of the word or statement that best answers the question or completes the sentence.

A 9. Land that contains relatively few people and large areas of open space is considered
a. rural.
b. urban.
c. suburban.
d. rangelands.

C 10. All of the following is allowed in wilderness *except*
a. research.
b. camping.
c. development.
d. fishing.

D 11. The timber industry classifies forestlands into three categories called
a. softwoods, hardwoods, and mixed woods.
b. pine, redwood, and mixed.
c. evergreen, deciduous, and mixed.
d. virgin forest, native forest, and tree farms.

Concept Review *continued*

A 12. A heat island can
- a. affect weather patterns over a city.
- b. reduce the average temperatures in a city.
- c. absorb less heat than vegetation.
- d. have a lower temperature than the surrounding countryside.

D 13. Tree harvesting methods include
- a. selective cutting.
- b. reforestation.
- c. clear-cutting.
- d. Both (a) and (c)

A 14. A fire station is an example of
- a. infrastructure.
- b. suburbanization.
- c. land-use planning.
- d. renovation.

B 15. Which of the following is *not* a method of preventing overgrazing?
- a. limiting herd size
- b. rotating the breed of cattle
- c. removing herds to allow vegetation to recover
- d. replanting native vegetation

D 16. Which of the following is *not* an environmental benefit of open spaces?
- a. moderation of temperatures
- b. absorption of rainwater runoff
- c. provision of aesthetic value
- d. source of lumber for homes

C 17. Which of the following is a benefit of preserving farmland?
- a. prime locations for home sites
- b. soil erosion protection
- c. productive land for growing crops
- d. a greenbelt for crowded urban areas

A 18. Which of the following uses the largest amount of land in the United States?
- a. forestland
- b. rangeland and pasture
- c. cropland
- d. parks and preserves